Comparison of Dry Mater Content of Pig Faeces in Two Belt Separation Systems

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Abstract. *The average production of slurry per animal per day lies between 3 and 7 kg during a period of swine fattening. Spain is the world's fourth largest producer of pork. The size of farms and their density are growing faster and faster. Therefore, slurry management is becoming an environmental problem due to air and soil pollution. Separating faeces and urine improves waste management and reduces the levels of environmental pollution. Since 1999 different systems aimed at this separation have been developed. In 2001, Vazquez et al. designed and patented a new integrated system for waste management in pig housing, based on a special, adjustable floor conveyor belt under a partial slat, to avoid slurry production. A full-size system has been built and installed at the Pig Welfare Laboratory, a pig fattening facility for a maximum of 240 animals located in Madrid, Spain. The separation system is based on the direct harvest of faeces and urine by means of a belt placed under the partial slats of the pen. Two types of belt were made for two types of handling. One of them is a flat belt of 0.6 m x 14 m with the possibility of up to 8° slope side to side and up to 2° lengthways. The other is a conventional belt with longitudinal inclination from 0º to 8º. The aim of this study was to analyze the performance of both belts comparing the characteristics of solids collected during a fattening period. Every fortnight samples of 250 cm^3 were taken and the percentage of dry matter was measured. This assessment took into account the interior and exterior temperatures registered in the laboratory. This study shows the technical feasibility of the patented system.*

Keywords. *Environmental, Swine, Manure, Separation system, Belt.*

Introduction

The 2005 pig census in Spain recorded a total of 24,884,000 animals, of which 43.5% are concentrated in the regions of Catalonia and Aragon, and 15% in Castilla y Leon, (MAPA, 2005). The herds are located within very specific areas of these regions and produce large quantities of slurry with no possibility of use on agricultural land. The management of this slurry incurs high costs due to the large quantities involved and the great difficulty of its elimination through treatment systems.

Average slurry production per animal per day is 3-7 kg over a fattening cycle, with a dry material content of 3-10%, (European Commission, 2003). This means that the volume of waste to be treated by the farmer and therefore the surface area needed to spread the slurry are very large. Since several years ago the law in Spain has limited the maximum amount of nitrogen that can be spread on agricultural land: 170 kg/ha, as stipulated in the European Union Directive 91/676/CEE on the protection of water from nitrate contamination from agricultural sources. This states that for every 100 fattening pigs an area of 4.5-6 ha is necessary to disperse the slurry without risk of soil or water table contamination.

Contamination is produced by excessive spreading of nitrates and phosphates on land. Nitrates in slurry derive fundamentally from the urine content and phosphates from the faeces, (C. Baird et al., 2005).Only Holland limit the maximum amount of nitrates allowed to be spread on land, with a maximum level of 80 kg P2O5/ha, (LNV and VROM, 2000).

For several years now different technical solutions have been sought for slurry management. In Spain the most frequently used method is storage in large lagoons of compacted earth, water-proofed with geotextile lining. This form of management does not resolve the problem due to the large quantities of slurry generated and the large surface areas of land that must be used by the farm.

Different authors have proposed solutions based on the separation of urine and faeces, (Ogink et al., 2000; Vázquez et al., 2001; Koger et al., 2003; Baird et al., 2005; Lachance et al., 2005). All suggest separation by means of a moving belt below slats. All the systems are experimental and are currently at the validation stage.

In this paper preliminary results are shown for dry material content of faeces collected in the separation system proposed by (Vázquez et al., 2001). Two types of belt with different slope angles are compared.

Materials and Methods

Facilities

The experiment was carried out in an experimental facility for fattening pigs with four independent rooms , six pens per room. Each pen measured 2.40 x 3.10 m with 40% of the surface area being slats, (1.2 m wide). In each area a slurry separation system by means of a conveyor belt under the slats was installed and ventilation was carried out by under floor extraction.

Two types of belt were used:

a) Belt with longitudinal adjustment. The longitudinal slope angle is regulated between 0º and 2º (0-3.5% slope). The belt is 0.6 m wide: as the slat width of the pen is greater than that of the belt, deflectors were placed along the length of the slat to form a type of continuous funnel for optimal material collection. This type of belt is installed in two of the rooms.

b) Belt with transverse adjustment: The side to side slope angle is regulated between 0º and 8º (0-14.5% slope). The belt is 0.6 m wide. As with the previous belt type deflectors and a scraper have been installed with the same function. On one side the belt has a gutter to collect the urine. This type of belt is installed in the other two rooms.

The slope angles remained the same during all of the fattening period and were as follows:

Belt with longitudinal adjustment: one belt at 1º (L-1º) and the other at 0.5º (L-0.5º).

Belt with transverse adjustment: one belt at 2º (T-2º) and the other at 4º (T-4º).

Animals

72 animals were used, (3 pigs per pen, 18 per room): the low animal density was due to the fact that the experimental housing was in its starting phase. Live weight at the start of the fattening period was 23±3.7 kg, then being fattened up to a final weight of 114.6±17.4 kg. They were fed hay to appetite. The distribution of initial weight in each room was similar. Each pen was dry cleaned daily.

Excretions fell onto the belts through the slats. The belts were emptied every 24 hours. The manure was stored in a container that was emptied weekly.

Data collection

Manure samples were taken from each belt 8 times (8 controls) through the fattening cycle. Once the container was empty and after the belts were operated, the excretions collected were homogenized and three samples were taken per room. To determine the percentage of dry material, the samples were oven dried at a temperature of 105º until reaching a constant weight.

Data analysis

The variance analysis of the data was carried out by the ANOVA process of the Statistical Analyses System (SAS Institute, 1995). For the data analysis the model included the factors 'belt type' and 'control', as well as their interaction; for the analysis of the data relating to each type of belt the model included the factors 'slope angle' and 'control' and their interaction. Before analyzing, the arcsen transformation $(x/100)^{0.5}$ was applied with the data of the %MS to guarantee the normal of the distribution. The averages were separated using the Duncan test ($P<0.05$).

Results

Table 1 shows the results for the dry material content of the faeces according to belt type and the slope angle. The belts with transverse adjustment separated the faeces from the urine more efficiently than the belts with longitudinal adjustment, (40.96 vs. 25.27 %DM). In the same way, for each type of belt the dry material content increased as the slope angle increased and whilst accepting that in both belt types there were significant differences, the effect of the change was much more acute in the transversely adjusted belts.

Table 1. Dry mater content of faeces: effects of belt type and slope angle

Belt	Angle	N	% DM	SEM
Belt with transverse adjustment		48	40.96 [a]	0.493
Belt with longitudinal adjustment		48	25.27 [b]	
Belt with transverse adjustment	4.0º	24	47.76 [a]	0.479
	2.0º	24	34.16 [b]	
Belt with transverse adjustment	1.0º	24	25.92 [a]	0.223
	0.5º	24	24.62 [b]	

a,b For each factor or combination of factors mediums with different superscripts differ significantly.

SEM is the Standard Error of the Mean.

Figure 1 shows the evolution of the dry material content of the faeces collected over the fattening period. The experiments had eight tests. The first test was done in mid-August, (the start of the fattening period) and the last one was done in mid-November (the end of the period).

Generally the dry material content of the faeces decreased as the fattening period went on. This could be due to the change in the air temperature of the ventilation (i.e. exterior temperature), and to the ventilation flows (related to aforesaid temperature). Thus, the daily quantity of manure produced, and therefore accumulated on the belts, increased as the size of the animals increased. All of these factors undoubtedly influenced the possibility of the faeces' water content evaporating through the air ventilation.

The same causes explain the extraordinarily high dry material content of the faeces from the transversely adjusted belt set at 4º during the first half of the fattening period: high external temperature, high ventilation flow and low daily manure production.

All of the above makes clear the importance of the ventilation system in housing equipped with faeces and urine separation facilities: the best option is ventilation with under floor extraction.

The dry material content of the faeces obtained with transversely adjusted belts is greater than that observed by other authors using similar belts (Koger et al., 2003; Baird et al., 2005; Lachance et al., 2005): this is likely to be related to the low animal density in our study.

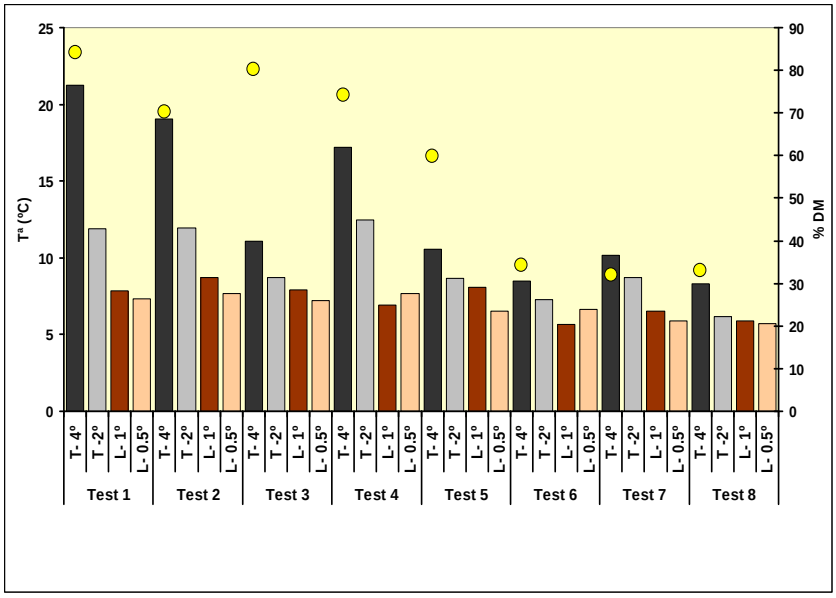

Figure 1. Evolution of the dry material content of the faeces collected over the fattening cycle

Conclusion

Separating faeces and urine by means of belts below slats is efficient, both for transverse and longitudinal adjustment.

A transverse slope is much more efficient than a longitudinal: with a transverse slope the amount of material collected increased considerably with greater slope angle.

Ventilation through under floor extraction is the most recommendable option in housing with faeces and urine separation by belt under slat.

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